Preliminary Amendment

In the Specification

[0022] As the atom % of boron increases, the film becomes more opaque. An atom % of greater than about 20% is not considered preferable for most uses, because as the boron concentration increases, it becomes more difficult to sufficiently etch the layer with an oxygen plasma in a process described below to form an opening in the ARC layer. With no boron doping in the amorphous carbon, the DARC layer will react with the photoresist to form a resist footing, and thus the resist layer cannot be formed directly on an amorphous carbon layer ~~which~~ with no boron doping. Thus it is preferable to dope the amorphous carbon layer with boron to between about 0.1 atom % and about 20 atom %.

In the Claims

1. (original) A method used to form a semiconductor device comprising:

forming a layer to be etched over a semiconductor wafer substrate assembly;

forming a boron-doped amorphous carbon (a-C:B) antireflective coating (ARC) layer over said layer to be etched;

patterning said a-C:B ARC layer to expose said layer to be etched;

etching said layer to be etched to pattern said layer; then

exposing said a-C:B ARC layer to an oxygen plasma.

2. (original) The method of claim 1 further comprising heating said a-C:B ARC layer to a temperature of between about 200°C and about 380°C during said exposure of said ARC layer to said oxygen plasma.

3. (original) The method of claim 2 further comprising exposing said ARC layer to said oxygen plasma for a duration of between about 20 seconds and about 120 seconds.

4. (original) The method of claim 1 further comprising:

prior to patterning said a-C:B ARC layer, forming a patterned photoresist layer over said a-C:B ARC layer;

patterning said a-C:B ARC layer using said patterned photoresist layer as a pattern during said patterning of said a-C:B arc layer to expose said layer to be etched; and

exposing both said photoresist layer and said a-C:B ARC layer to said oxygen plasma.

5. (original) The method of claim 1 further comprising introducing a fluorine-containing gas into said oxygen plasma during said exposure of said a-C:B ARC layer to said oxygen plasma.

6. (original) The method of claim 1 wherein said layer to be etched is a dielectric layer and said method further comprises:

forming an opening in said dielectric layer during said etching of said layer to be etched; and

subsequent to exposing said a-C:B ARC layer to said oxygen plasma, forming a conductive layer within said opening in said dielectric layer.

7. (original) The method of claim 1 wherein said exposure of said a-C:B ARC layer to said oxygen plasma forms an ashed a-C:B layer and said method further comprises exposing said ashed a-C:B layer to a solution comprising both phosphoric acid and ammonium fluoride.

8. (original) A method for patterning a layer to be etched which overlies a semiconductor wafer, comprising:

forming a boron-doped amorphous carbon layer on said layer to be etched;

forming a photoresist layer on said boron-doped amorphous carbon layer;

patterning said photoresist layer and said boron-doped amorphous carbon layer; and

etching said layer to be etched to pattern said layer to be etched using said pattern of said patterned boron-doped amorphous carbon layer as a pattern.

9. (original) The method of claim 8 further comprising removing said photoresist layer and said boron-doped amorphous carbon layer by:

exposing said photoresist layer and said boron-doped amorphous carbon layer to an oxygen plasma to form an ashed photoresist layer and an ashed boron-doped amorphous carbon layer subsequent to etching said layer to be etched; and

exposing said ashed photoresist layer and said ashed boron-doped amorphous carbon layer to an acid.

10. (original) The method of claim 9 further comprising introducing a fluorine-containing gas into said oxygen plasma during said exposure of said boron-doped amorphous carbon layer to said oxygen plasma.

11. (original) The method of claim 9 further comprising exposing said ashed photoresist layer and said ashed boron-doped amorphous carbon layer to a solution comprising phosphoric acid and ammonium fluoride during said exposure of said ashed photoresist layer and ashed said boron-doped amorphous carbon layer to said acid.

12. - 16. (canceled)

17. (new) A method used to form a semiconductor device, comprising:

forming a layer to be etched over a semiconductor wafer substrate assembly;

forming a amorphous carbon layer over the layer to be etched, wherein the amorphous carbon layer is doped with boron to between about 0.1 atom % and about 20 atom %;

forming a patterned photoresist layer over the amorphous carbon layer;

patterning the amorphous carbon layer using the patterned photoresist layer as a pattern;

etching the layer to be etched using the pattern of the photoresist layer as a pattern; and

subsequent to etching the layer to be etched, exposing the amorphous carbon layer to an oxygen plasma to remove the amorphous carbon layer.

18. (new) The method of claim 17 wherein the amorphous carbon layer is doped with boron to between about 1 atom % and about 10 atom %.

19. (new) The method of claim 17 wherein the amorphous carbon layer is doped with boron to between about 5 atom % and about 10 atom %.

20. (new) The method of claim 17 wherein the formation of the amorphous carbon layer comprises:

placing the semiconductor wafer substrate assembly into a chamber;

heating the chamber to a temperature of between about 200°C and about 450°C;

introducing propylene into the heated chamber at a flow rate of between about 200 standard cm^3/minute (sccm) and about 1,000 sccm, diborane at a flow rate of between about 100 sccm and about 2,000 sccm, and helium at a flow rate of between about 0.0 sccm and 1,000 sccm; and

during the introduction of propylene, diborane, and helium into the heated chamber, subjecting the chamber to a radio frequency power of between about 300 watts (W) and about 1,000 W and a pressure of between about 3.0 torr (T) and about 7.0 T.

21. (new) The method of claim 17 further comprising exposing the semiconductor wafer substrate assembly to a wet etch for a duration of between about 5 minutes and about 10 minutes subsequent to exposing the amorphous carbon layer to the oxygen plasma.

22. (new) The method of claim 17 further comprising exposing the amorphous carbon layer to a fluorine-containing oxygen plasma during the exposure of the amorphous carbon layer to the oxygen plasma.

23. (new) The method of claim 17 further comprising introducing a material selected from the group consisting of CF_4, NF_3, CH_2F_2, and CHF_3 to the oxygen plasma during the exposure of the amorphous carbon layer to the oxygen plasma.

24. (new) The method of claim 17 further comprising removing the patterned photoresist layer during the exposure of the amorphous carbon layer to the oxygen plasma.